CURRENT PROCEDURES FOR CHEMICAL THINNING APPLES

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Department of Horticulture Mimeograph Series No. 309

The need to prevent alternate bearing and limb breakage in trees, and improve the size and quality of fruit dictates that many apple varieties should be thinned. Inexpensive chemical sprays can be used very effectively to accomplish this very laborous and costly orchard operation. However, before any fruit thinning program will work effectively the grower must believe in its success and necessity. This has long been the stumbling block to successful and economical fruit thinning; that is, many apple producers have not been convinced that fruit thinning is an absolute necessity. All too often, fruit thinning has taken a back seat in importance to other orchard operations. The most important steps in making a chemical thinning program work is the desire to learn how this is best accomplished and then have the determination to put the practice in use.

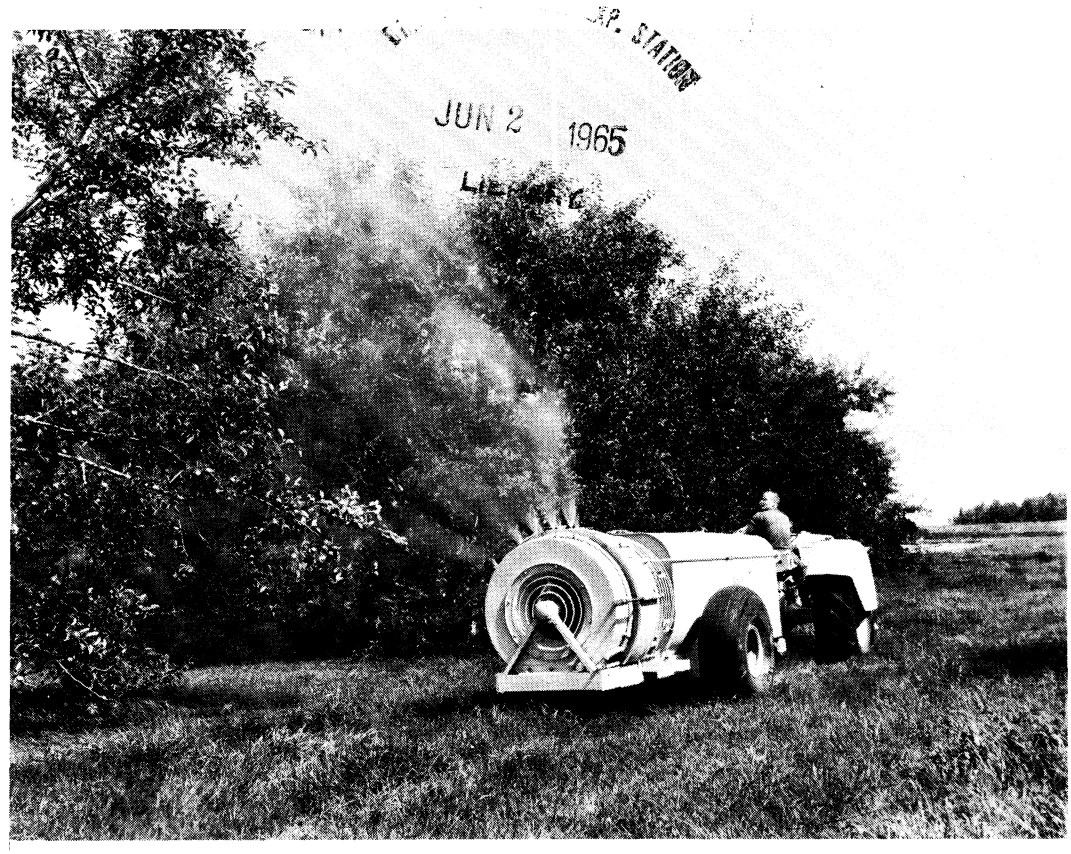

Figure 1. - Orchard being thinned with chemical sprays. This operation requires approximately 20 seconds of labor per tree. A comparable job of hand thinning may require from 2 to 3 hours of hand labor per tree.

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OBJECTIVES OF CHEMICAL THINNING

1. Reduce labor costs.
2. Prevent alternate bearing
3. Improve fruit color.
4. Reduce limb breakage.
5. Increase annual yield of marketable fruit.
6. Improve fruit size.
7. Improve eating quality of fruit.
8. Maintain tree vigor.

To do a safe and satisfactory job with chemicals, one must know what materials to use and how much to use for different apple varieties. Timing the application is also extremely important.

MATERIALS AND RATES

The variety to be thinned is the most important factor to consider when deciding what material to use for chemical thinning. Since varieties differ greatly in their response to different thinning chemicals, no one chemical can be recommended for all varieties. Listed below are the chemicals that have been found through research at the Ohio Agricultural Experiment Station to be the most effective thinning materials for varieties indicated.

I. Amide (75 ppm at petal fall) + Sevin (2 lbs/100 gal. water 5 days after petal fall if needed)

Varieties

1. Close
2. Transparent
3. Lodi
4. Wealthy

II. Sevin 50 WP (applied 7 to 10 days after petal fall)

Varieties	Amount/100 gal. water
1. Red Delicious	1½ to 2 lbs.
2. McIntosh	1½ to 2 lbs.
3. Northern Spy	1½ to 2 lbs.
4. Grimes Golden	1 to 1½ lbs.
5. R. I. Greening	1 to 1½ lbs.

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III. NAA (naphthaleneacetic acid) or Amide (naphthaleneacetamide)

Concentrations to use: Selection of low, normal, or high concentration of NAA depends upon environmental and growth conditions prior to the application date. See discussion below.

Varieties	NAA ppm Low	Normal	High	or Amide (ppm)
1. Golden Delicious				65 to 75
2. Rome Beauty				" "
3. Gallia Beauty	15	20	25	" "
4. Lowery				" "
5. Maiden Blush				" "
6. Baldwin				" "
7. Miami				" "
8. Summer Rambo				
9. Idared				
10. Melrose	12	15	18	60
11. Melba				
12. Monroe				
13. Crandall				
14. Ruby				
15. Jonathan				50
16. Stayman				Do not use
17. Red Gravenstein	7.5	10	12.5	50
18. Franklin				Do not use

Concentrations of NAA to Use:

- If NAA is used to chemically thin the fruit, concentrations of this material should be adjusted for different environmental and growth conditions that occur prior to the application date. Four factors that are important to consider are temperature, rainfall, sunlight, and tree vigor. This can be accomplished by taking daily weather records between the pink stage of blossom development and the date NAA sprays are applied. The previous year's terminal shoot growth is probably the best measure of tree vigor.

Daily weather records can be easily and quickly taken and recorded by using a simple rain gauge to measure rainfall and a minimum-maximum thermometer to obtain the average daily temperature. Average daily temperatures and rainfall can then be compared with U.S. Weather Bureau records of the geographical area to determine if the average daily temperature and rainfall have been below average, average, or above average for the period of time between pink stage and application date for NAA sprays.

An accumulated daily temperature below normal indicates a need for a low concentration of NAA. An accumulated daily temperature above average, however, indicates a need for a high concentration of NAA.

Since only monthly rainfall averages are usually available from the U.S. Weather Bureau, accumulated orchard rainfall for a 30-day period (preceding the application of NAA) is compared to the average rainfall of the month that most closely covers the rainfall recording period. This will usually be the month of May in Northeastern Ohio. If the 30-day period should be nearly equally divided between two months (such as the

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latter part of April and the first part of May), then the average of the two months normal rainfall can be used as a comparison figure. A high concentration of NAA is suggested if the accumulated rainfall in the orchard is as much as 0.75 inches below the normal average rainfall. Conversely, a low concentration of NAA is suggested if the accumulated orchard rainfall is as much as 0.75 inches above the normal average rainfall.

Sunlight can be estimated at the end of each day and recorded as a numerical value ranging from 1 to 5. The value 1 indicates a continuous cloud cover all day, 2 mostly cloudy all day, 3 partly cloudy, 4 mostly sunny all day, and 5 continuous sunlight all day. By summing and averaging the estimated sunlight values for all days during the weather recording period, one can determine if sunlight has been below average (1 to 2.5), average (2.5 to 3.5), or above average (3.5 to 5).

The table 1 illustrates the type of records that should be recorded to establish the environmental conditions existing prior to the time NAA is applied. These data were recorded, beginning at the pink stage of blossom development, for the first week of weather recording period of 1963.

Table 1. Daily weather records obtained in 1963 at the Ohio Agricultural Experiment Station, Wooster, Ohio.

Date	Max. Temp.	Min. Temp.	Av. Temp.	Wooster 76 Year Av. Temp.	Temp. Diff.	Rainfall	Sunlight
Apr. 29	60	50	55	55	0	.56	2
Apr. 30	55	30	43	55	-12	.11	2
May 1	46	28	37	55	-18	0	3
May 2	62	32	47	55	- 8	0	5
May 3	70	48	59	56	+ 3	0	3
May 4	74	53	64	55	+ 9	0	5
May 5	60	38	49	56	- 7	.05	2

A yardstick can be used to measure the terminal shoot growth for estimating the vigor of mature bearing trees. The previous season's growth of 20 terminal shoots should be measured on three or four trees in the area of the orchard to be sprayed with NAA. Below average tree vigor would be indicated by trees with an average terminal shoot growth of less than 5 inches. Average tree vigor would be indicated by trees with average terminal shoot growth of 5 to 12 inches, and above average tree vigor would be indicated by trees with average terminal shoot growth greater than 12 inches.

With the records pertaining to temperature, rainfall, sunlight and tree vigor, the concentration of NAA can then be calculated. Examples which follow illustrate how the environmental and growth records were used in 1963 and 1964 at the Ohio Agricultural Experiment Station to determine the concentration of NAA for thinning Golden Delicious and Jonathan apples.

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Year 1963

Conditions at Wooster, Ohio, prior to application date (pink stage to application date)

	NAA Concentrations (see page 2) Jonathan	Golden Delicious
1. Temperature (below average)	7.5 ppm (low)	15 ppm (low)
2. Rainfall (below average)	12.5 ppm (high)	25 ppm (high)
3. Sunlight (average)	10.0 ppm (normal)	20 ppm (normal)
4. Tree Vigor (average)	10.0 ppm (normal)	20 ppm (normal)
	40.0	80

NAA Conc. for Jonathan = 40 ÷ 4 = 10 ppm
-2 ppm for 32°F temp. that occurred just prior to NAA application date.
8 ppm

NAA Conc. for Golden Delicious = 80 ÷ 4 = 20 ppm
-2 ppm for 32°F temp. that occurred just prior to NAA application date.
18 ppm

Year 1964

Conditions at Wooster, Ohio, prior to application date (pink stage to application date)

	NAA Concentrations (see page 2) Jonathan	Golden Delicious
1. Temperature (above average)	12.5 ppm (high)	25 ppm (high)
2. Rainfall (above average)	7.5 ppm (low)	15 ppm (low)
3. Sunlight (above average)	12.5 ppm (high)	25 ppm (high)
4. Tree Vigor (average)	10.0 ppm (normal)	20 ppm (normal)
	42.5	85

NAA Concentration for Jonathan = 42.5 ÷ 4 = 10.6 or 11 ppm
NAA Concentration for Gol. Delicious = 85 ÷ 4 = 21.2 or 21 ppm

By using the above method, Jonathan trees were sprayed with 8 ppm and Golden Delicious with 18 ppm of NAA in 1963. However, under the different environmental conditions of 1964, Jonathan were sprayed with 11 ppm and Golden Delicious with 21 ppm of NAA. The results of these tests indicated this to be a very satisfactory method for determining the NAA concentrations to use. Similar calculations could be made each year by the grower to determine concentrations of NAA to use on all apple varieties that are to be thinned chemically.

TIMING THE THINNING SPRAY

Proper timing of spray application is a "must" if chemicals are to be successfully used to thin apples. If Amide is used, the applications should be made at petal fall just prior to the application of pesticide sprays. Recent research at the Ohio Agricultural Experiment Station has indicated that NAA should be applied in relation to fruit size rather than to the number of days after bloom or petal fall as has been suggested in the past.

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For NAA to be most effective, the material must enter the fruit at a specific stage of fruit development. Data from a three year study have shown that NAA will give the most consistent thinning if the applications are made at the time the largest fruit on the trees reach 15 - 18 mm in length. Because growing conditions are different from one year to the next, the dates for most effective NAA application may vary from 5 to 18 days after petal fall.

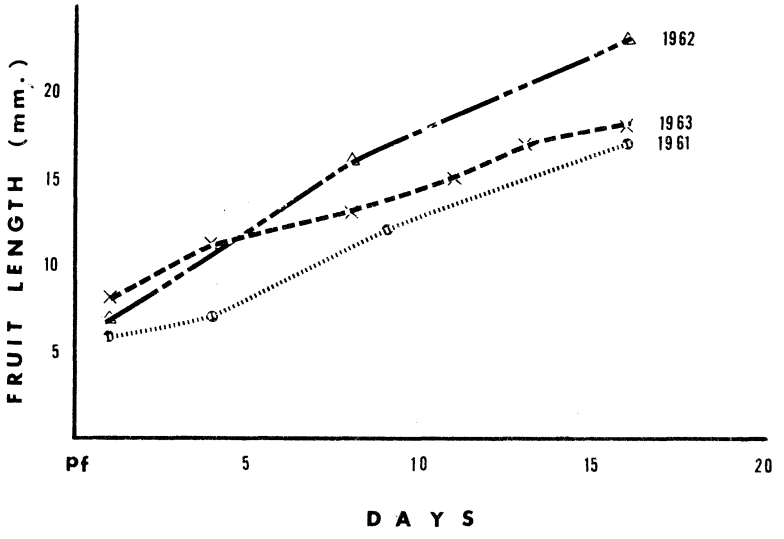

Figure 2. Average length of largest fruit removed from Jonathan apple trees from 1 to 16 days after petal fall (Pf) in 1961, 1962, and 1963. Wooster, Ohio

Figure 2 illustrates the differences in growth rates of developing Jonathan fruit during three years. In 1961, the rate of fruit growth was rather slow immediately after petal fall and it was 13 to 16 days before the fruit reached 15 - 17 mm in length. The following year, 1962, the fruit grew rapidly attaining the 15 - 18 mm length 7 to 10 days after petal fall. In 1963, the increase in fruit length was even more rapid for the first 4 days but because of a change in environmental conditions, growth rate decreased and it was 11 to 15 days after petal fall before the fruit grew to 15 - 18 mm in length. Of importance is the fact that every year after the fruit reached 15 mm in length, there was a 3 to 4 day interval before it reached 18 mm. This indicates that there would be some choice in selecting a good spraying day for making NAA applications.

Different apple varieties have also been found to enlarge at different growth rates following petal fall. Varieties such as Lowery or Maiden Blush may need to be sprayed with NAA as much as a week earlier than Golden Delicious or Jonathan.

To properly adjust for these differences in varieties and growing conditions, the following procedure is suggested for predicting the time to make an NAA application:

> Beginning 3 or 4 days after petal fall, measure the length of several of the largest fruit that can be picked from the ground for each apple variety that is to be thinned. The only equipment needed is a pen knife and a small plastic millimeter ruler. The fruit should be split in half (lengthwise) and measured with the plastic ruler. See Figure 3 for an example of the area to be measured. When the largest fruit reaches the appropriate length shown in Figure 2 (15 - 18 mm) apply the NAA thinning sprays on the next acceptable

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day Once measurements are started they should be made every day (preferably early morning or late afternoon) until the fruit reaches the proper thinning size.

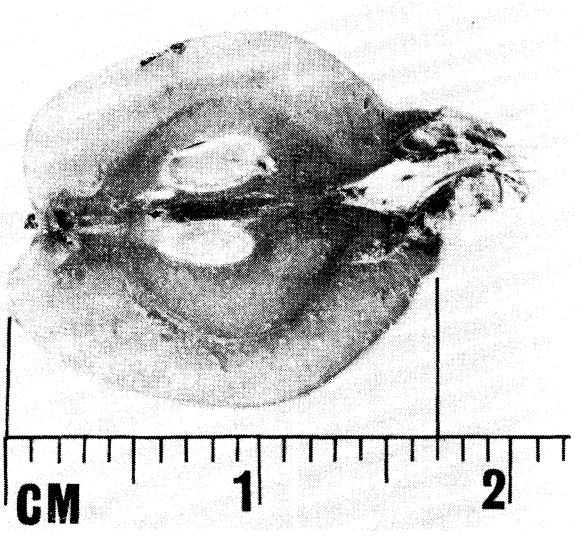

Figure 3. Photographic enlargement of a Jonathan fruit which shows the size (1.7 cm or 17 mm) suggested for making NAA applications. Photograph also illustrates the area of the apple that is to be measured when determining length of the fruit.

WHEN TO APPLY

Ideally thinning materials should be applied on a calm day when the temperature is not below 60°F or above 75°F. It is suggested that applications of Sevin, Amide, or NAA be made late in the afternoon. There is evidence that sunlight destroys the naphthalene molecule so application late in the day should give the best opportunity for these materials to be absorbed by the trees. It is important, however, to spray the trees early enough in the afternoon to ensure drying before night-fall.

MOST PROBABLE CAUSE OF FAILURE

Success or failure in thinning fruit with chemicals often depends upon many factors which the grower can control if he is well informed about the exact procedures of the chemical thinning operation. Listed below are several reasons why underthinning or overthinning often results when chemicals are used for this purpose.

Underthinning Often Results From:

1. Failure to completely wet trees when spraying with recommended concentrations of thinning materials. If dilute spraying is used and the applications are made with an air blast sprayer, make sure the trees are sprayed to the drip point.

2. Failure to increase concentration of thinning materials to correspond with setting of air blast sprayer for concentrate spraying or sprayer improperly adjusted resulted in delivery of too few gallons per minute for desired concentration.

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3. Failure to adjust concentration of thinning material for vigorous growing trees (greater than 12" terminal growth). If trees are mature and vigorous and have been difficult to chemically thin in the past, increase recommended concentrations (see previous discussions).

4. Failure to make the thinning application at the time fruit is most susceptible to the chemical. (See Figure 2).

5. Failure to adjust concentration of thinning materials following several weeks of warm, sunny, dry weather. If such conditions exist prior to application dates, increase concentration of thinning material (see previous discussions).

Overthinning Often Results From:

1. Failure to adjust concentration of thinning material for weak trees (less than 5" terminal growth). If trees are weak or showing any signs of tree decline, decrease recommended concentration (see previous discussions).

2. Failure to use the recommended chemical or recommended concentration of the chemical for different apple varieties.

3. Failure to use a lower concentration of thinning material immediately following cold temperatures ($32^{o}F$ or lower). Concentration of NAA should be lowered by 2 ppm after such conditions.

4. Failure to properly adjust air blast sprayer when using concentrate spraying for applying thinning materials.

5. Failure to decrease concentration of thinning materials following several weeks of cool, cloudy, rainy weather. If unfavorable conditions exist prior to application date, lower recommended concentration (see previous discussions).

ADDITIONAL THINNING AIDS

Investigations at the Ohio Agricultural Experiment Station have revealed that two important orchard operations, in addition to using chemicals, must be employed if one is to expect the best possible thinning results. These operations involve pruning and hand thinning to supplement the chemical thinning program.

Pruning:

Pruning methods should be changed to keep pace with the demand for up-to-date fruit growing practices. To do a creditable job of applying thinning chemicals with an air blast sprayer, trees must be pruned for maximum spray coverage. This may involve thinning out and lowering of older trees to a height of 15 to 18 feet. All fruiting wood in the tree that will not produce well-colored, high-quality apples should be removed. Fruit thinning should always be one of the objectives in pruning mature trees.

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Hand Thinning:

The third and final step of the chemical thinning program could be referred to as the "clean-up" phase, and this involves hand thinning. If the first two operations have been carried out successfully then the time required to finish up the thinning operation by hand will be very small. This third step is necessary to ensure proper distribution of fruit on the trees.

SUMMARY

A carefully thought out and planned chemical thinning program supplemented by pruning and hand thinning can be a very effective and economical means for promoting annual bearing of orchards and improving the size and quality of the fruit. An effective fruit thinning program can mean the difference between profit and loss for an orchard operation, especially if the producer is only realizing returns from his planting every other year because of the alternating bearing of the trees brought about by overcropping.

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